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Tech Snapshot Manufacturing

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PSEUDO-HOT-ISOSTATIC PRESSING (P-HIP)

Advanced manufacturing of high uniform density complex shaped components



SUMMARY

Researchers at Los Alamos National Laboratory developed a technology to produce high performance ceramic or metal with a combination of major key properties such as versatile-complicated shape, high density, uniform density distribution, and minimal amounts of starting material. The novel pseudo-hot-isostatic-pressing (P-HIP) uses graphite or boron nitride flakes as the stress transmission media to transmit stress instead of the conventional solid graphite punch. The graphite and boron nitride flakes are solid lubricants and can slide among one another to re-distribute the stress from high stress concentration area to the low stress concentration areas, resulting in a self-stress-relief action. This innovative P-HIP enables the manufacturing of complicated shapes with near-net-shape capability while minimizing the energy used and reducing waste. This is a revolutionary breakthrough to the ceramics and powder metallurgy industries.

BENEFITS

The P-HIP technology is an advanced manufacturing technology that can deliver higher quality, near-net-shape components with a faster production rate, reduced production cost and enhanced the quality of the final product.

- Enables the uniaxial hot pressing to achieve near-net-shape component with high density and uniform density distribution throughout the whole component.
- Minimizes machining effort resulting in increased production rate, energy saving, reduction of machining waste.
- Applies to various ceramic and powder metallurgy components with almost any complicated shape and size.
- Enhances the performance through high density and uniform density distribution.



MARKET APPLICATION

The target markets for near-net-shape P-HIP technologies are ceramic and powder metallurgy (PM) applications that require high-quality, complicated shapes of uniform high-density material that can be manufactured in batch production. Advanced high-density materials are needed because premature failure or lower performance of a key component could result in a major failure of an integrated system. The technology has an extensive range of applications including space shuttles, power plant components, neutron moderators for nuclear power plants, turbine engine blades, armor for vehicles, soldier's helmets, helicopter armor seat protection, and oil and drilling components.

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WHY WE ARE BUILDING PSEUDO-HOT-ISOSTATIC PRESSING (P-HIP)

P-HIP can be applied to various ceramic and powder metallurgy components with almost any complicated shape and sizes. Advanced Manufacturing (AM) and Design for Manufacturing (DfM) are two major missions within LANL's agenda to map future needs for technologies to produce advanced materials of complex shapes. The goals require a near-net-shape hot pressing technology that can achieve a high density and uniform density distribution without any cracking. This near-net shape P-HIP technology can minimize the energy consumption and material waste caused by the extensive machining of the simple blank shape. This technology also provides a batch type advanced manufacturing technology that can deliver higher quality components with a faster production rate.



WHAT'S BEHIND OUR TECHNOLOGY

Hot pressing is a longstanding production method which has had little improvement over the last 100 years. Novel P-HIP uses graphite or boron nitride flakes as a stress transmission media instead of the conventional solid graphite punch of hot pressing. These flakes act as solid lubricants to redistribute the stress evenly. Parts can be made in complex shapes and with high uniform density. P-HIP can outperform the rest of the technologies including conventional hot pressing, slip casting, Cold-Isostatic-Pressing, extrusion, and injection molding.



OUR COMPETITIVE ADVANTAGES

Conventional hot pressing can only achieve simply shape component that requires extensive machining. Uniaxial hot pressing using a complicated shape solid graphite punch resulting in cracking of the component due to the thermal expansion coefficient mismatch. P-HIP technology is a novel near-net-shape hot pressing technology that enables complicated shape with high density, uniform density distribution, minimized raw material use, minimized energy used for machining, minimized machining waste to the environment, minimized energy required to produce diamond grinding tools.



OUR TECHNOLOGY STATUS

The P-HIP technology has been successfully demonstrated on the medium size bowl shape with high density and uniform density distribution. A scale-up to larger component has been successfully proven for a wide range of sizes. The P-HIP team has also demonstrated production of different shape parts of silicon carbide, aluminum nitride, and other materials. A provisional patent has been filed in 2021 and the P-HIP technology is ready for license as well as to partner with private industry for additional develop to fulfill their special needs.



PUBLICATIONS AND IP

Provisional patent filed in November 2021: "Uniaxial-Hot-Pressing for Making Near-Net-shape Parts Using Solid Stress Transmitting Media", S167555.000